

APPLICATION FOR UNITED STATES LETTERS PATENT

by

SCOTT C. HOLT

and

ROBERT A. KOCH

for

**SYSTEMS AND METHODS FOR MONITORING NETWORK-BASED VOICE
MESSAGING SYSTEMS**

SHAW PITTMAN LLP
1650 Tysons Boulevard
McLean, VA 22102-4859
(703) 770-7900
Attorney Docket No.: BS01-143

SYSTEMS AND METHODS FOR MONITORING NETWORK-BASED VOICE MESSAGING SYSTEMS

BACKGROUND

Field of the Invention

[0001] The present invention relates generally to telecommunications systems, and more particularly, the present invention relates to enhanced network-based voice messaging services.

Background of the Invention

[0002] Telephone systems have become a central means for communicating with others on a real-time basis. However, for a variety of reasons, it is generally not possible or convenient for subscribers to answer every telephone call received. For example, with the high volume of junk calls (e.g., telemarketing, wrong numbers, and the like) many subscribers choose not to answer an incoming call. Subscribers may screen their calls using an answering machine that allows them to monitor the message as the caller records it. If the subscriber then recognizes the caller as someone he wants to speak to, he can override the answering machine and take the call. Answering machines have also been beneficial in those circumstances where the subscriber is not available to receive a call. In that case, the caller can still leave a message for the subscriber.

[0003] However, answering machines are vulnerable to malfunction due to loss of power, depleted recording media, and the like. Furthermore, if the subscriber's line is busy, the caller cannot get through to leave a message on an answering machine. To solve these problems, telecommunications service providers have developed network-

based voice messaging systems (VMS). Such systems are generally maintained in controlled environments with adequate backup power supplies and redundant systems for high reliability. Furthermore, VMS systems may be configured to receive inbound calls when the subscriber's line is not available. Accordingly, conventional VMS systems have greatly improved the capabilities for subscribers to ensure callers can leave a message when the subscriber does not answer a call. A problem remains, however, for those subscribers who desire the capability to monitor messages as they are being recorded and the capability to intervene in the call to speak to the caller.

[0004] Figure 1 shows how conventional voice messaging services operate. PSTN domain 100 includes telephony systems such as switches 102 and 104. Switch 102 serves the subscriber's telephone 106 and switch 104 serves voice messaging system (VMS) server 108. Switches 102 and 104, for example, may be the same switch or may be different switches as shown in Figure 1. Switches 102 and 104 may be a circuit-switched service switching points (SSPs) such as the switches used in advanced intelligent networks (AIN) or may be a packet-switched network element. PSTN domain 100 also comprises PSTN 110 which may include for example, local exchange carriers, competitive local exchange carriers, long distance carriers, and the like. PSTN 110 may provide a network link between switches 102 and 104, as shown in Figure 1.

[0005] When a caller, using, for example, telephone 116 calls the subscriber at telephone 106, the call will be processed by the subscriber's host switch 102 in the normal manner. If subscriber line 106a is busy or the call is not answered, the call is forwarded from switch 102 to VMS server 108 via PSTN 110 and switch 104. VMS

server 108 may provide a message to the caller prompting him to record a message. VMS server 108 may also provide a variety of other options to the caller (e.g., message priority, replay recorded message, and the like).

SUMMARY OF THE INVENTION

[0006] The present invention provides systems and methods for monitoring a call directed to a network-based voice messaging service (VMS) via packet-based network conferencing resources, such as, for example an IP-based voice-over-IP telephony system. The system and method use one or more media gateway systems providing an interface between a conventional telephony domain and the Packet-switched data network domain. When a call is to be redirected to the VMS system, it is routed via the Packet-switched data network domain using the media gateway. An application server in the Packet-switched data network domain maintains registration information associated with the subscriber. If the subscriber is logged onto the Packet-switched data network domain, the conferencing resources are used to establish a conference call between the caller, the VMS and the subscriber.

[0007] In embodiments of the present invention, the subscriber may actively participate in the conference call. That is, as with conventional answering machines, the subscriber may listen to the caller leaving a message with the voice messaging service and decide to answer the call. In this case, the voice messaging service may be dropped from the conference call.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a schematic diagram showing a conventional implementation of a network-based voice messaging system.

- [0009] Figure 2 is a schematic diagram showing an implementation of an embodiment of the present invention.
- [0010] Figure 3A is a schematic diagram showing an embodiment of the present invention including a presence database.
- [0011] Figure 3B is a schematic diagram showing the voice path that may be used in an embodiment of the present invention when a subscriber is not available to monitor the call.
- [0012] Figure 4 is a flow diagram showing exemplary steps that may be used to carry out an embodiment of the present invention.
- [0013] Figure 5 is a schematic diagram showing additional communications paths that may be used in an embodiment of the present invention.
- [0014] Figure 6 is a schematic diagram of an architecture that may be used to implement an alternative embodiment of the present invention.
- [0015] Figure 7 is a schematic diagram of an architecture that may be used to implement an another alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

- [0016] The present invention provides systems and methods for allowing a subscriber of a network-based voice messaging service to remotely monitor callers as they record messages to the subscriber's voice messaging service. The invention further provides systems and methods for allowing the subscriber to interrupt callers as they are recording a message, so that the subscriber may intercept the telephone call and speak to the caller.

Architecture Used In An Exemplary Embodiment

Sub B' [0017] In an exemplary embodiment, a telephony network is integrated with a data network to provide an affordable system for carrying out the present invention.

Figure 2A shows an architecture that may be used to implement an embodiment of the present invention. For clarity in this description, Figure 2A shows two basic domains: Public switched telephone network (PSTN) domain 100 and packet-switched data network domain 200. However, the line of demarcation between the domains is arbitrary. PSTN domain 100 includes the same elements as described above in relation to Figure 1. As noted above, packet-switched data network domain 200 may be any suitable data network, including, for example, an Internet Protocol (IP) network.

[0018] Media gateways 112 and 114 may provide an interface between PSTN domain 100 and packet-switched data network domain 200. Packet-switched data network domain 200 may comprise conference server 202, call agent 204, application server 206, presence database 208 and packet telephony client 210. In an embodiment of the present invention, media gateways 112 and 114 may be the same gateway, that is a single system may be used to provide an inbound and outbound interface between telephony domain 100 and Packet-switched data network domain 200. Packet telephony client 210 may be collocated with telephone 106 (i.e., the subscriber may implement a monitoring system to screen calls forwarded to voice mail using a computer system in proximity to his subscriber telephone). Alternatively, packet telephony client may be at a remote location allowing the subscriber to monitor calls

31
from other locations. The functions and operations of these systems (i.e., gateways, servers, packet telephony client, and the like) are described in more detail below.

Operation In An Exemplary Embodiment

[0019] When a caller, using, for example, telephone 116 calls a subscriber at telephone 106, the call may be processed by the subscriber's switch 102 in the normal manner. That is, the switch may attempt to terminate (i.e., connect) the call to the subscriber's line 106a. If subscriber line 106a is busy or the call is not answered, the call may be forwarded from switch 102 to inbound media gateway 112 via communications link 10. As shown in Figure 2, communications link 10 may provide a voice path from switch 102 to media gateway 112. Communications link 10 may also transport information about the call, such as, for example, the calling party number (CgPN) and the called party number (CdPN) (i.e., the directory number associated with subscriber line 106a). Upon receiving the call, media gateway 112 may notify, via communications link 1, call agent 204 that an inbound call has been received. As shown in Figure 2, communications link 1 may provide a data path from media gateway 112 to call agent 204. The notification message may include information that may be used to identify the subscriber, such as, for example, the CdPN.

[0020] Call agent 204 may be any system adapted to provide call control functions in a voice-over-data network. An example of a suitable call agent may be a softswitch system, such as, for example, the Alcatel 1000 Multimedia Multiservice Exchange (available from Alcatel, Paris, France) and switches provided by other vendors including, for example, Lucent Technologies (Murray Hill, New Jersey), Sonus

Networks (Westford, Massachusetts), and the like. Call agent functions may also be provided via a media gateway controller, such as for example, the Cisco Media Gateway Controller (available from Cisco Systems, San Jose, California), and the like. When call agent 204 receives the inbound call notification, it may notify application server 206 via communications link 2, which provides a data path between the systems. Application server 206 may be any suitable computer system that has a central processor, a memory and application processing logic. Application server 206 provides the processing logic for implementing an embodiment of the present invention.

[0021]

Application server 206 may include one or more databases used to store configuration information related to the service. For example, a database may be used to store one or more network addresses (e.g., an IP address, if the underlying data network is an IP network) associated with the subscriber's packet telephony client 210. Such databases may be internal to application server 206 or may be some other database system (not shown in the Figures). Packet telephony client 210 is a network system associated with the subscriber of the service. Packet telephony client 210 may be any suitable voice-over-data system, such as for example, voice-over-IP systems. In an embodiment of the present invention, packet telephony client 210 may comprise a software application running on a computer system. In another embodiment, packet telephony client 210 may comprise a network appliance adapted to provide voice-over-data network service. Voice-over-data systems may be based on the well-known H.323 communications protocol, session initiation protocol (SIP), or some other suitable packet telephony protocols. The network address for packet

telephony client may be a pre-defined network address. That is, in some embodiments, a subscriber may be known to use the same packet telephony client system to monitor incoming calls according to the present invention. In other embodiments, a subscriber may use multiple packet telephony clients or may not have a statically-assigned network address. In this case, the subscriber may log-in or register each time he begins a session to inform the network of his address. Such notification may be manually performed by the subscriber or may be an automatic process initiated, for example, whenever the user logs into his computer system.

[0022]

Sub
B2

In one embodiment of the present invention, which may be implemented using an architecture show in Figure 2A, application server 206 instructs call agent 204 to initiate call legs between the caller, the VMS system, and the client telephony client through conference server 202 even if the subscriber is not available at packet telephony client 210. In this embodiment, application server 206 may first instruct call agent 204 to set up call legs (i.e., voice paths) 12, 14, and 16 from inbound media gateway 112 to conference server 202, from conference server 202 to media gateway 114, and from outbound media gateway 114 to VMS server 108 (via switch 104), respectively. Call agent 204 may send appropriate instructions to inbound media gateway 112, conference server 202 and outbound media gateway 114 via communications links 1, 3 and 4, respectively. Accordingly, in this embodiment, application server 206 does not check to determine whether or not the subscriber has actually logged into the network and conference resources are allocated to provide a voice path between the caller and VMS server 108.

[0023] In this embodiment, application server 206 may then look up a network address associated with packet telephony client 210. The look up may include, for example, searching for the CdPN (i.e., the subscriber's DN) in a database to locate the associated network address. Once the network address has been determined, application server 206 may instruct call agent 204 to set up a call leg from conference server 202 to packet telephony client 210.

[0024] Application server 206 may instruct call agent 204 to send an invitation to the subscriber to join the conference call. In response to the instruction, call agent 204 may send a message to packet telephony client 210 via communications link 6. The message may inform the subscriber that a caller is recording a message to his voice messaging system and may provide an opportunity for the subscriber to monitor the call. If the subscriber accepts the invitation, a voice path may be established, via communications link 20, between packet telephony client 210 and conference server 202. Once all of the voice paths have been established, a three-way conference call is in progress between the caller at telephone 116, VMS server 108 and the subscriber at packet telephony client 210. If the subscriber declines the invitation, or there is no response from packet telephony client 210, the call between the caller and VMS server 108 continues unimpeded, but still utilizes resources on conference server 202.

Operation Using A Presence Database

[0025] In other embodiments of the present invention, application server 206 may first query whether or not the subscriber is available to monitor his calls. The architecture shown in Figure 3A may be used to implement such embodiments. Figure 3A includes all of the components described in Figure 2 and additionally

includes presence database 208. Application server 206 may query a database or other information file to make this determination. The database may be internal to application server 206 or may be an external database such as presence database 208, in communication with application server 206 via communications link 5. In this embodiment, application server 206 instructs call agent 204 to allocate conference resources only if the subscriber is available (i.e., the subscriber has registered or logged onto the data network and indicated that he wants to monitor messages as they are recorded to voice messaging system server 108).

[0026] If the subscriber is not available, then application server 206 instructs call agent 204 to set up call legs directly between inbound media gateway 112 to outbound media gateway 114. Figure 3B shows how a resulting voice path may be established between the caller and VMS server 108, through media gateway 112, communications link 20, media gateway 114 and communications link 16. As shown in Figure 3B, the voice path in this situation need not connect through a conference server, thereby preserving conference resources for other uses.

Operation From A Subscriber's Perspective

[0027] Once the voice paths have been established between the caller at telephone 116, VMS server 108 and packet telephony client 210, the subscriber (if he is using packet telephony client 210) may passively monitor the conversation between the caller and the VMS system. That is, the subscriber may monitor the caller's message as it is being recorded to VMS server 108 without interrupting the caller. In some embodiments of the present invention, the subscriber's leg of the call may be controlled by software on packet telephony client 210. That is, packet telephony

client 210 may include logic for ensuring that the subscriber's monitoring of the call is a one-way communication. One reason such control may be desirable is to prevent the caller from knowing that the call is being screened. A one-way communication may also be established by, for example, muting the microphone on packet telephony client 210. In other embodiments of the present invention, conference server 202 may be adapted to ensure a one-way communication to the subscriber.

[0028]

Sub
B4

In other embodiments of the invention, if the subscriber has multimedia capabilities (e.g., a microphone and speakers) on packet telephony client 210 he may be provided the capability to accept the call and become a full participant in the call. For example, in one embodiment of the present invention, the subscriber may select an option provided by programming logic on packet telephony client 210 to join the call. In this embodiment, packet telephony client 210 may send a message to call agent 204 indicating the subscriber's intent to answer the call. Call agent 204 may then instruct conference server 202 to drop VMS server 104 (and media gateway 114) from the call. Packet telephony client 210 (or conference server 202) may then allow a two-way communication between the caller and the subscriber, via conference server 202.

[0029]

In another embodiment, even if the subscriber does not have multimedia capabilities on packet telephony client 210, he may still be provided the capability to intercept the call via a telephone device, such as telephone 118, telephone 106, or some other telephone (not shown in the Figures). In this embodiment, the subscriber may send a message (via packet telephony client 210) to call agent 204 instructing it establish a call leg to the telephone device. Call agent 204 may instruct conference

server 202 accordingly, and the subscriber may then answer the call on the telephone device and speak to the caller. VMS server 108 (and media gateway 114) and packet telephony client 210 may then be dropped from the conference call.

Operation From A Caller's Perspective

[0030] The above described steps (i.e., message transactions between the application server, media gateways and other network elements) generally take place very quickly. Accordingly, there need not be any significant delay in connecting the caller to VMS server 108. From the caller's point of view, the call appears to be a conventionally routed call to the subscriber's voice mail. Unless the subscriber is provided capability to "pick up" the call, and actually does so, the caller may not be aware of the additional call processing steps described herein.

Process Flow In One Embodiment

[0031] Figure 4 shows a flow diagram of steps that may be carried out in an embodiment of the present invention. As described above, computer programming logic for performing these steps may be performed by application server 206 or in a system combining functionality of application server 206 and call agent 204. In step 400 a call to a subscriber of a network-based voice messaging server is received at the switch servicing the subscriber's line. In steps 402 and 404, if the subscriber's line is not busy, the switch terminates the call to the subscriber's line in a conventional manner. The subscriber's line then rings or otherwise provides an alert. If, in step 406, the call is answered, no further call processing is required and the process ends. Otherwise, if the call is not answered, the process moves on to step 408 and the call is

forwarded to an inbound media gateway. Similarly, if in step 402, the subscriber's line is busy or not available, the process moves on to step 408 as shown in Figure 4.

[0032] After the inbound media gateway receives the call, it sends a message to an application server in step 410 (via a call agent system). The message may include the calling party number or other information identifying the call received on the inbound media gateway. The message may also include the called party number or other information identifying the subscriber. In step 412, the application server may check a presence database to determine whether or not the subscriber is currently registered on the IP network. If, in step 414, the application server determines that the subscriber is registered on the IP network, the application server sends a message to a conference server (via a call agent system) instructing the conference server to initiate a three-way conference call between the inbound media gateway, the subscriber and the voice messaging service in step 416.

[0033] Otherwise, the process moves on to step 418 where the call is forwarded from the inbound media gateway to the outbound media gateway. As noted above, in some embodiments, a single media gateway may be used. In this case, step 418 would not be performed and the process would move on directly to step 420. In step 420 the caller is connected to the subscriber's voice messaging service via the media gateway(s). After connecting the caller to the subscriber's voice messaging service, the process ends as shown in Figure 4.

[0034] If the subscriber is registered on the IP network, the process continues in steps 416 and 422, where the conference server sets up the conference call between the caller, the subscriber and the voice messaging service. If an outbound media gateway

is used, then the conference call includes the outbound media gateway in the call path to the subscriber. After step 422 has been completed, the subscriber may monitor the communication between the caller and the voice message system. In an embodiment of the present invention, the caller is not provided any cues indicating that the call has been transferred to the voice messaging server via the IP network. Accordingly, in some embodiments, the caller may not be made aware that the subscriber is able to listen in on the communication.

[0035] As described above, the subscriber may elect to intervene in the call. If, in step 424, the subscriber makes a request to take the call, the process moves on to step 426. The subscriber may request to receive the call on a conventional telephone device or via the subscriber's client system. If the subscriber wishes to use a conventional telephone, the subscriber may provide a directory number for the telephone to which the call should be directed. Alternatively, the subscriber may have pre-identified a directory number as part of a registration process. In either case, the conference server (via a call agent system) may be directed to drop the voice messaging server from the conference call as indicated in step 426.

[0036] Figures 5-8 show alternative embodiments of the present invention. Each of the embodiments include many of the components described above. Figure 5 shows an embodiment wherein packet telephony client 210 is in direct communication with the application server 206 and conference server 202 in addition to call agent 204. Such direct communication may be useful, for example, in embodiments wherein applicable programming logic associated with the present invention is operated on each of the systems. That is for example, if conference server 202 is adapted to

receive instructions directly from packet telephony client 210, communications link 7 may be used. Similarly, if packet telephony client 210 needs to send registration information to applicable server 206, communications link 8 may be used.

[0037] Figure 6 shows an embodiment wherein the programming logic and functionality of application server 206 and call agent 204 have been combined into a single component. In this embodiment, application server/call agent 600 may include communications links 601-605 as shown in Figure 6.

[0038] Figure 7 shows an embodiment wherein the programming logic and functionality of application server 206, call agent 204 and conference server 202 are combined into a single component. Application server/call agent/conference server 700 includes data paths 701-704 and voice paths 710 and 712 as shown in Figure 7.

[0039] The foregoing disclosure of the preferred embodiments of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many variations and modifications of the embodiments described herein will be apparent to one of ordinary skill in the art in light of the above disclosure. The scope of the invention is to be defined only by the claims appended hereto, and by their equivalents.

[0040] Further, in describing representative embodiments of the present invention, the specification may have presented the method and/or process of the present invention as a particular sequence of steps. However, to the extent that the method or process does not rely on the particular order of steps set forth herein, the method or process should not be limited to the particular sequence of steps described. As one of

ordinary skill in the art would appreciate, other sequences of steps may be possible. Therefore, the particular order of the steps set forth in the specification should not be construed as limitations on the claims. In addition, the claims directed to the method and/or process of the present invention should not be limited to the performance of their steps in the order written, and one skilled in the art can readily appreciate that the sequences may be varied and still remain within the spirit and scope of the present invention.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228